COLOR PROOFING OPTIONS AND ISSUES FOR THE GRAPHIC ARTS

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The options for proofing in the graphic arts are dependent on two major factors; a. the needs at a particular point in the workflow and b. whether the workflow process is analogue or digital.

The issues for the analogue process are well known, however the digital process has at least eleven major issues to be addressed.

3M's efforts at addressing these digital issues are reflected in the specifications for 3M Digital Matchprint ^{TM} color proofing system.

Introduction

There is a great deal of confusion in the graphic arts market today regarding proofing. A proof can be anything from a black and white photocopy to a 2400 dpi four color digitally generated halftone print. If we say that a proof is a way to visualize and communicate information in hardcopy prior to some production process, then we can begin to define different types of proofs by user needs and workflow. There is one additional factor that we need to consider in proofing and that is whether the workflow is digital or analogue.

Process Workflow and Proof Requirements

In the production of any printed page, there are three basic stages that the page passes through. These phases may be completed by different people in different organizations. A proof at each stage is common to check the work in progress for content, style and visual appearance.

The first stage is the Concept or Design stage. The proof requirement is to get a general idea of the design and content of the page. Often many designs of the page are considered at this stage. The second stage is the Preproduction stage. Here, the page is prepared for printing and the proof requirement is to check the assembly process. The final stage is the Production and printing of the page. The proof has four basic uses at this stage; a. Verification, b. Press Prediction, c. Communication and d. Contract. The proof must verify everything in the process up to the press for such factors as text content and quality, color separation and balance, and assembly. The proof is also then used as a target for the press to visually reproduce. Finally the proof is used to communicate what the page will look like among all the parties involved from designer to final client. In this way it becomes a contract among the parties. Therefore its primary requirements are consistency and predictability. Proofs at this stage are often called Critical Color proofs.

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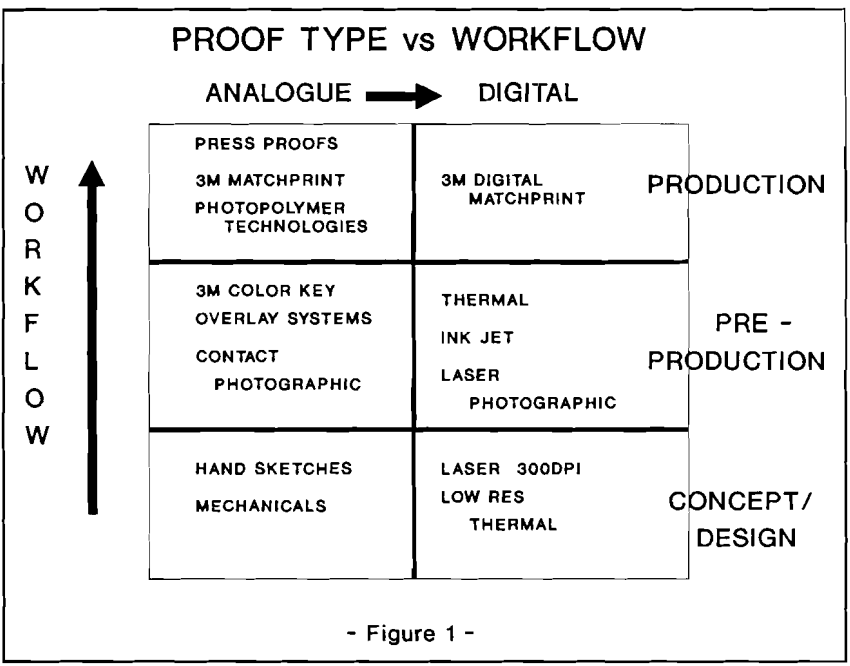
Today, the technology trend for the workflow is from a materials and labor intensive process to a digital process. In the past, proofs were generally imaged in an contact mode from graphic arts film. For terminology's sake, these can be called Analogue or Contact Proofs. In the digital process, proofs can be imaged directly from digital data without an intermediate step. These we call Digital proofs.

Figure 1 then defines six basic areas of proofing seen in the market today.



- Figure 1 -

The technologies used to fill the Analogue workflow process are hand drawings or sketches an the Concept/Design phase. Overlay systems such as 3M Color Key^{TM} or photographic proofs are used in the Preproduction phase. Photopolymer or single sheet proofs such as 3M Matchprint^{TM} or press proofs are used in the final production stage.

The technologies currently used in the digital world are low resolution (300dpi) laser or thermal prints in the Concept stage. The advantages of this technology are relatively low cost and high speed. These are the output devices to the PC page design systems. In the Preproduction category we find direct imaged photographic systems, ink jet and thermal printers with gray scale. In the Production stage we find systems which must meet all the resolution and consistency requirements of a Critical Color or Contract proof. There are very few entrants in this area today, however this is the area that 3M has targeted for 3M Digital Matchprint.

Issues In Digital Proofing

In the realm of Digital proofing there are many new issues which are different than those in Contact proofing. Figure 2 lists them briefly.

Digital Proofing Issues

1. Flexibility vs Consistency	6. Interfacing
2. Control	7. Speed
3. Proofing Standards	8. Cost vs Benefit
4. Compatibility	9. Format
5. Text & Graphics Integration	10. Serviceability

11. Environmental Safety

- Figure 2 -

1) Flexibility vs. Consistency

One of the first issues related to the Production Digital Proofing category is the flexibility that is required to accurately and consistently predict color. The proofing system must take into account the inks, dot gains, densities, and paper stocks that are associated with the intended print process, as well as the screen rulings, angles and dot shapes that will ultimately be used to make the final films. All of these parameters must be adjusted to simulate the intended characteristics of the process that will be used to generate the printed page.

Does the flexibility mean that the process is inherently inconsistent? How can a user be sure that the proof is really simulating the printed work?
These questions lead to the next major issue in critical color digital proofing...CONTROL.

2) Control

In the same way that your film recorder must be tightly controlled and calibrated to give a consistent result, a digital proofing system must also be controlled. Control can be automatic within the system by using internal measurement and control loops, or manual by measuring the output of the system and entering calibration settings or look-up-tables. Control involves more than the mechanical and electronic hardware. The materials used to create proofs must be manufactured to extremely tight tolerances in order for the proofing system to accurately produce a consistent result. If the proofing system cannot produce a consistent proof, it cannot be used to make critical color judgments. The proofing system must be more consistent than the final printed job.

Even if all of the flexibility is tightly controlled to give a consistent result, how can you know if it is an *appropriate* consistent result?...By specifying the proofing STANDARDS that are used.

3) Proofing Standards Selection

In order to know what conditions the digital proofing system is trying to simulate, appropriate proofing standards must be selected as the normal conditions under which a proof is made. When 3M developed its Matchprint^{TM} product line it adopted the most common industry printing conditions (SWOP and Commercial) as the standards which the product would simulate. This achieved two results. For presses that were running to SWOP standards, Matchprint^{TM} has provided a consistent prediction of the final printed sheet from that press. For presses that were supposed to be running to SWOP standards, but were slightly out of adjustment, the Matchprint^{TM} proof became a target, used to adjust the press back to within the standard SWOP tolerances.

These two uses of the proof as a predictor and a target require that the standard proofing conditions be thoughtfully selected and calibrated before actually proofing a production job. The proofing conditions cannot be modified to make a particular proof look "better". The proofing system must simulate real life standard conditions and the original digital data must be adjusted to achieve the desired output. After all, it is the digital data that will ultimately be used to generate the film or engrave the cylinder that will generate the final printed product. Only after the appropriate selection and accurate measurement of standard proofing conditions will the digital proof have an accurate relationship to the printing process.

4) Compatibility with Conventional Proofing

Since very few printing organizations have a work flow that is entirely digital, many customers will continue to use Matchprint^{TM} as their prepress proofing standard. For those customers, it is important that a digital proofing system be able to produce the same consistent results as Contact or Analogue proofing system. Both proofing methods must have the same colorimetric responses and be on the same bases. Digital proofing must be compatible with conventional prepress proofs in order to meet this important work flow requirement.

5) Text and Graphics Integration

Because of the time required to scan high resolution text into a CEPS (Color Electronic Pagination System), text is often added to pages using other methods. A proof is not a final proof until it includes all of the type.

Text and line art are often on film. These films can either be scanned into the CEPS system, or directly into a digital proofing system for digital integration into the proof. Page description languages like Adobe's PostScript^{TM} are also becoming common digital formats for type. Therefore, digital proofing systems must have the ability to incorporate text from several sources into the proof, and an output resolution to accurately reproduce the text in the proof.

Critical color proofs will have limitations in the quality of the type that can be proofed because of resolution limits. Higher resolution proofing systems will allow better prediction of the final printed result.

6) Interfacing

Interfacing is another major issue for any digital proofing system. It is not just a question of what to interface to, but how to interface. The interface can have a major effect on the productivity of both the proofing system and the CEPS or scanner.

For example, data formats vary widely between systems from different manufacturers. How much additional processing must be done to data before it is transferred to a proofing system? Can the digital proofing system accept all of the data (contone, run length encoded, and high resolution edge) that the system will ultimately use to make the film? The DDES standard (ANSI IT8.4) has started to make system data more interchangeable, but it does not yet cover all of the data within the system and is not supported by all vendors.

What about the interface itself? Is transferring a tape from a CEPS to a proofing system really a viable and productive interface strategy? What about on-line interfaces? How fast can data actually be transferred and what other operations are suspended during the transfer?

You need to determine both the work flow and system configuration that optimizes the use of all your electronic hardware.

7) Speed

There are many dimensions to the speed of a digital proofing system. Most of the issues revolve around how you measure speed.

Some proofing systems require the CEPS systems to pre-process the data before sending it to the proofing system. This processing can take over 30 minutes.

There is also data transfer time. As was mentioned earlier, the efficiency of an interface, as well as the ability to accept multiple data types, can have significant effect on the productivity of both the CEPS and the proofing system.

Once the proofing system has the data, there may be some preprocessing time required to organize the information, rotate the page to fit on the proofer, or calculate the halftone screen.

Next, there is the time to actually produce the proof. This is usually the time stated by manufacturers when indicating the "speed" of a system. However, this time can be insignificant compared to the amount of time required for the other steps used to produce a digital proof.

Finally, there may be some post processing required to finish the proof. This may be a separate lamination step or post exposure.

When evaluating the speed of a digital proofing system you should analyze all of the steps between the time when you decide you would like to make a proof and the time you have the finished proof in your hand. Most of the critical color proofing systems will utilize multi- or co-processing technology to maximize the number of proofs that can be underway at one time. However, the co-processing time is not free, especially if part of it takes place on your CEPS system.

8) Cost vs. Benefit

Another issue is the cost of digital proofing compared to the benefit. Critical color digital proofing will not be "inexpensive" to purchase. 3M has made many technological breakthroughs

and developed highly sophisticated hardware and materials in order to commercialize our product. This new level of performance will require more capital investment than most conventional prepress proofing systems.

However, because critical color digital proofing may be more expensive than the proofs made by lower performance systems, it does not mean these systems will not be profitable to use. What are the major costs and benefits related to critical color digital proofing?

The primary components of any thorough cost calculation are similar. The principal direct costs associated with digital proofing are the hardware investment, materials cost, labor, machine service, and maintenance. There are also indirect costs, such as pre-processing time on a CEPS. These costs must be analyzed on a proof-by-proof basis in order to do a reasonable comparison between the cost of different proofing systems.

For example, hardware and service costs must be allocated over the number of proofs that are made during a given time period. It is easy to see that the "cost per proof" depends on the number of proofs the system is able to make during that time period and the number you are able to make given your production volume and requirements for multiple copies. The more proofs you make, the lower this allocation becomes. The materials and labor costs will tend to be fixed on a proof-by-proof basis. The cost of materials will depend on the actual process being used by the proofing system. Labor cost is related to the degree of automation that the vendor has designed into the proofing system. Real cost comparisons can be made between systems only by looking at these total costs.

What about the benefits? There are many. The reduction in proofing turnaround time is one obvious benefit. By eliminating the need to output film, send it to the proofing department, and wait for the proof to be produced, there will be a short turnaround time for critical color digital proofs. This benefit can save both time and customers.
Faster turnaround time means more than faster corrections. It also allows greater learning by system operators. Today, when films are output to make proofs, the corrected proof may not come back to the system department until the next shift or even the next day. Often, the operator who did the original work on a job is not the one who does the additional corrections. The original operator does not know if the job was done correctly and the new operator must spend expensive time to become familiar with the job. Critical color digital proofing will help improve your quality and productivity by allowing operators to quickly see the results of their work.

There are other benefits to digital proofing. For example, film will only be created when the job is completed, signed off and ready to go to press. Depending on how many proofing iterations a job normally goes through, this can double or triple the capacity of your current film recorders. You will save money on the film cost, the system cost and the recorder time.

As you can see, there are many benefits of digital proofing. Not only will critical color digital proofing make the proofing operation more efficient, it can improve the entire operation of the plant.

9) Format

An issue related to critical color proofs is format size and orientation. A larger format allows you to proof a large image, or several images on one sheet. Unfortunately, cost varies directly with format size. Larger format recorders cost more to produce. The optics and the controls all become more complex. However, the benefit of larger sizes may offset the higher costs.

Image orientation is also related to format size. All data stored in a CEPS is in either the horizontal or vertical direction. If the CEPS data orientation does not match the proof orientation, the data must be rotated before proofing. Rotation of image data can be very time consuming. Even if it is done simultaneously with another operation, it still slows down the overall proofing cycle. Therefore, it is important to analyze the orientation of the data you want to proof and compare it with the orientation requested by various proofing systems.

10) Serviceability

The issue of serviceability is important in today's time and production driven businesses. Questions of how much maintenance on a daily, weekly or monthly basis need to be answered. As has the system been designed for easy serviceability? The system must also have the reliability to be an effective production tool?

11) Environmental Safety

The last major issue concerns environmental safety. The issue of pollution is awakening in the public interest on a global basis. Products introduced today must meet tough new emissions and safety laws. However, since we can no longer afford to export our problems to other regions. We must consider the total materials/energy/emissions equation for the printing process as well as just proofing. By doing this we can begin to look at questions such as what is the total amount of pollution introduced or saved by any new process or product. Digital proofing in general will help cut the materials/energy/emissions equation for printing a page and this can benefit us all.

At 3M we are in the process of scaling up a revolutionary and proprietary new digital proofing system we call 3M Digital Matchprint.^{TM} The process is based on liquid electrophotography.

The system specifications are as follows:

Technology	- Electrophotography
Process	- Halftone
Production Time	- A 2 Page Spread in About 12 Minutes
Color Match Standards	- ISO-FIPP-GRAVURE SWOP-COMMERCIAL
Inking Stations	- Four
Resolution	- Over 2400 Lines/Inch For High Quality Text And Image
Line Screen Ruling	- Up To 175 Lines/Inch
Dot Shapes	- Round, Elliptical and Square

Dot Retention	- From 3% to 95%
Dot Gain	- Adjustable & Operator Defined
Gloss Level	- Adjustable & Operator Defined
Density	- Adjustable & Operator Defined
Formats	- A3 or Two Page Spread - Scatter Proofs
Substrate	- Standard Matchprint Bases - Most Printing Stocks
Interfaces	- CEPS - Scanners - IT8.4

Summary

Critical color digital proofing will become a commercial reality in the near future. 3M has been working with you through our development process to study and analyze the issues related to digital proofing, as well as building off our history as a proofing leader with our Matchprint^{TM} II and Color Key^{TM} products. As you try to make a decision about digital proofing, 3M will be here to help you make those decisions, and to offer you cost effective solutions.